

REMARKS

Favorable reconsideration of this application in light of the following discussion is respectfully requested.

Claims 1-3 and 7-11 are currently active in this case. Claims 6 and 12-17 have been cancelled by a previous amendment. In the present amendment, Claim 1 is amended without introducing any new matter, and Claims 4-5 are cancelled without prejudice or disclaimer.

In the September 8, 2008 Office Action, Claims 4-5 were rejected under 35 U.S.C. § 112, second paragraph, as not further limiting the scope of the preceding claim. Claims 1-5, and 7-11 were rejected under 35 U.S.C. § 102(b) as anticipated by Sato et al. (Japanese Patent Publication JP 2001-093524, hereinafter "Sato"). Alternatively, Claims 1-5 and 7-11 are were rejected under 35 U.S.C. § 103(a) as unpatentable over Zhuang et al. (Publication of the Journal of Alloys and Compounds, "The 673 K isothermal section of the La-Ni-Sn ternary system," Vol. 363, No. 1, Jan. 28, 2004, pp. 228-231, hereinafter "Zhuang") in view of Sato.

First, Applicants wish to thank Examiner John S. Maples for the courtesy of an interview granted to Applicants' representative Nikolaus P. Schibli, Ph.D., Reg. No. 56,994, on January 14, 2009, at which time the outstanding issues in this case were discussed. Arguments similar to the ones developed hereinafter were presented and Examiner Maples indicated that in light of the arguments, he would reconsider the outstanding grounds for rejection upon formal submission of a supplemental response.

In response to rejection of Claims 4-5 under 35 U.S.C. § 112, second paragraph, these claims are herewith cancelled without prejudice or disclaimer.

In response to the rejection of Claims 1-5 and 7-11 over Zhuang under 35 U.S.C. § 103(a), Applicants herewith provide English translations for the Japanese priority documents JP 2003-113190 and JP 2003-336246, together with a statement that the translations are

accurate, to perfect the claim to priority. Accordingly, Zhuang is not prior art against the present application, and Applicants respectfully request withdrawal of this reference.

In response to the rejection of Claim 1 under 35 U.S.C. § 102(b), Applicants respectfully traverse the rejections, and request reconsideration thereof, as next discussed.

Briefly summarizing, Applicants' amended independent Claim 1 is directed to a nonaqueous electrolyte secondary battery. The battery includes a positive electrode, a negative electrode including an alloy having a CeNiSi₂ type crystal structure, and a nonaqueous electrolyte. In addition, the alloy is made of a ternary alloy system that has a composition represented by a formula LnM_{1x}M_{2y}, where Ln denotes at least one kind of element selected from the elements having an atomic radius falling within a range of 1.6×10^{-10} m to 2.2×10^{-10} m, M₁ is at least one element selected from the group consisting of Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn, and Nb, M₂ is at least one element selected from the group consisting of P, Si, Ge, Sn and Sb, and x and y satisfy the conditions of $0.5 \leq x \leq 1.5$ and $1.5 \leq y \leq 3.5$.

As described in Applicants' specification from page 31, line 21, to page 32, line 18, the features of Applicants' Claim 1 regarding the ternary system alloy lead to the unexpected result of permitting the lithium ions to be easily interposed between the adjacent layers of the crystal. It is an important aspect of the features of Claim 1 that the lithium ions do not react with the ternary system alloy, so as to be bound into the alloy crystals.

The inventors of the invention as recited in Claim 1 have found that in case the atomic radius exceeds the given range of 1.6×10^{-10} m to 2.2×10^{-10} m, it would be difficult to maintain the claimed crystal type structure. Moreover, as explained in the specification at page 33, l. 18, to page 34, l. 2, in case the atomic ratio y of the element M₂ of the ternary system alloy is lower than 1.5, which is outside the claimed range, the battery's capacity is reduced if the current density in the charge-discharge stage is increased. In addition, as

explained at page 34, ll. 3-8, if the atomic ratio y of the element M2 of the ternary system alloy exceeds 3.5, the life cycle of the battery is shortened. Examples of the manufacturing process of the ternary alloy are described in Examples 18-31, from page 54, line 22, to page 55, line 4 of Applicants' specification. Please note that the above discussion is for explanatory purposes only, and is not intended to limit the scope of the claims.

Turning now to the outstanding rejections, the pending Office Action asserts that Sato teaches the features of Applicants' Claim 1 related to the chemical elements and atomic radiuses. Applicants respectfully disagree with this position and traverses this position, as next discussed.

First, Sato fails to teach a ternary alloy system. Sato's Tables 1, 2 and 3 show material compositions having three elements,¹ but these material compositions are not crystal structures of alloys. It is a mere list of the elements that can be found in the phases A, B and C of the battery electrodes, as next discussed.

The reference Sato is directed to active material for non-aqueous electrolyte rechargeable batteries to preserve long life-time of the batteries. (Sato, ¶ [0001], ¶ [0008]). Sato describes a material composition of chemical elements that aims to suppress mechanical expansion stress between A phase and B phase pulverized material, that is caused by charge-and-discharge of batteries. (Sato, ¶ [0008], ¶ [0021]). The active materials described in Sato include, as shown in his Tables 1-4, not only A phase and B phase, but also C phase and other phases in some cases. (Sato, ¶¶ [0039]-[0040].) In the attached copies of Tables 1-4 that are taken from Sato, the columns have been denoted by reference symbols (a) to (i), and a translation from Japanese to English is herewith provided:

- (a) Example Number
- (b) Composition of Active Material
- (c) A phase

¹ See col. 2 of Tables 1-3, with Table 1 at row 12, 14-16, 19, 24-25, Table 2 at row 26-27, 30, 32, 48, and Table 3 at row 52, 54, 57.

- (d) B phase
- (e) C phase
- (f) Other phases
- (g) Initial Discharge Capacity (mAh/g)
- (h) Capacity Maintenance Rate (%)
- (i) Comparative Example Number

a	b	c	d	e	f	g	h
実施例	活性物質組成	A相	B相	C相	その他の相	初回放電容量 (mAh/g)	容量維持率 (%)
1	FeSn	FeSn ₂	FeSn	-	-	750	78
2	Fe _{0.8} Sn	FeSn ₂	FeSn	Sn(7)	-	820	71
3	Fe ₃ Sn ₂	FeSn ₂	FeSn, Fe ₃ Sn	-	-	640	88
4	Fe ₂ Sn	FeSn ₂	FeSn, Fe ₃ Sn	-	Fe	610	94
5	CoSn	CoSn ₂	CoSn	-	-	770	75
6	Co ₂ Sn	CoSn ₂	CoSn	-	Co	830	91
7	CoSn ₂	CoSn ₂	CoSn	Sn(5)	-	880	89
8	MnSn	MnSn ₂	Mn ₂ Sn	-	-	690	81
9	Mn ₂ Sn	MnSn ₂	Mn ₂ Sn, Mn ₃ Sn	-	-	590	94
10	Mn _{2.5} Sn	MnSn ₂	Mn ₂ Sn, Mn ₃ Sn	-	Mn	550	97
11	Mn ₂ Sn ₃	MnSn ₂	Mn ₂ Sn	Sn(8)	-	780	77
12	FeMnSn ₂	FeSn ₂ , MnSn ₂	FeSn, Mn ₂ Sn	-	Fe	740	81
13	ZrSn	ZrSn ₂	Zr ₄ Sn	-	-	700	80
14	KFeSn ₂	KSn ₂	FeSn	-	Fe	630	79
15	LaNi ₂ Sn	LaSn ₂	Ni ₃ Sn ₂ , Ni ₃ Sn	-	-	450	96
16	PdCu ₃ Sn	PdSn ₂	Cu ₃ Sn	-	Cu	440	97
17	NiSn	Ni ₃ Sn ₄	Ni ₃ Sn	Sn(2)	-	520	94
18	Fe ₆ Sn ₂	FeSn	Fe ₃ Sn	Sn(2)	-	480	95
19	KMnSn ₂	KSn	K ₂ Sn, Mn ₃ Sn	-	-	520	87
20	Ti ₃ Sn ₂	Ti ₆ Sn ₅	Ti ₂ Sn, Ti ₃ Sn	-	-	640	89
21	TiSn	Ti ₆ Sn ₅	Ti ₂ Sn	Sn(5)	-	850	81
22	Cu ₃ Sn ₂	Cu ₆ Sn ₅	Cu ₃ Sn	-	-	670	95
23	CuSn	Cu ₆ Sn ₅	Cu ₃ Sn	Sn(6)	-	720	86
24	FeCuSn	Cu ₆ Sn ₅	Cu ₃ Sn, Fe ₆ Sn	-	-	650	82
25	Fe ₂ CuSn	Cu ₆ Sn ₅	Cu ₃ Sn, Fe ₁₂ Sn	-	-	580	87

Table I

a	b	c	d	e	f	g	h
実施例	活物質組成	A相	B相	C相	その他の相	初回放電容量 (mAh/g)	容量維持率 (%)
26	Fe ₃ CuSn	Cu ₆ Sn ₃	Cu ₃ Sn	-	Fe ₁₉ Sn	520	93
27	TiFeSn	Ti ₃ Sn ₆	Ti ₃ Sn, Fe ₃ Sn	-	-	600	91
28	Ti ₂ Sn	Ti ₂ Sn	Ti ₃ Sn	-	-	630	96
29	Ti _{1.8} Sn	Ti ₂ Sn	Ti ₃ Sn	Sn(4)	-	690	94
30	Mg ₂ FeSn ₂	Mg ₂ Sn	Fe ₃ Sn	-	Mg	710	89
31	KMnSn	K ₂ Sn	Mn ₃ Sn	Sn(3)	-	570	89
32	CeCu ₂ Sn	Ce ₂ Sn	Cu ₄ Sn	-	-	530	91
33	CeSi	CeSi ₂	Ce ₂ Si	-	-	740	84
34	TiSi	TiSi ₂	TiSi, Ti ₃ Si ₃	-	-	710	90
35	Zr _{0.8} Si	ZrSi ₂	ZrSi	Si(4)	-	700	85
36	V ₃ Si ₂	VSi ₂	V ₃ Si	-	-	640	89
37	NbSi	NbSi ₂	Nb ₅ Si ₃	-	Nb	580	91
38	Mo ₃ Si ₂	MoSi ₂	Mo ₃ Si	-	Mo	620	88
39	W ₂ Si	WSi ₂	W ₃ Si ₂	-	W	520	94
40	MnSi	MnSi ₂	MnSi, Mn ₃ Si	-	-	660	87
41	FeSi	FeSi ₂	FeSi, Fe ₃ Si ₃	Si(1)	Fe	590	94
42	Fe ₃ Si ₂	FeSi ₂	FeSi, Fe ₃ Si	Si(2)	-	630	92
43	CoSi	CoSi ₂	CoSi, Co ₂ Si	Si(2)	-	650	88
44	Co ₃ Si ₂	CoSi ₂	CoSi, Co ₂ Si, Co ₃ Si	-	-	570	93
45	NiSi	NiSi ₂	NiSi	Si(7)	-	730	78
46	Ni ₂ Si	NiSi ₂	NiSi, Ni ₃ Si ₂	-	-	510	89
47	CuSi	CuSi ₂	Cu ₄ Si ₃	-	Cu	660	85
48	Ti ₂ BaSi ₂	BaSi, TiSi	Ti ₃ Si ₃	-	-	580	87
49	Ti ₂ Si	TiSi	Ti ₃ Si ₃	Si(4)	-	820	84
50	Co ₂ Si	CoSi	Co ₂ Si	Si(1)	-	600	89

Table II

a	b	c	d	e	f	g	h
実施例	活物質組成	A相	B相	C相	その他の相	初回放電容量 (mAh/g)	容量維持率 (%)
51	Fe ₂ Si	FeSi	Fe ₃ Si ₃	-	-	490	92
52	FeMoSi	FeSi	Mo ₃ Si	Si(2)	-	510	89
53	Mn ₂ Si	MnSi	Mn ₅ Si ₃ , Mn ₂ Si	-	-	480	93
54	PdFeSi	PdSi	Fe ₃ Si ₃	-	Pd	480	91
55	Mn ₃ Si	Mn ₃ Si ₃	Mn ₃ Si	-	-	440	96
56	Co ₂ Si	Co ₂ Si	Co ₃ Si	Si(3)	-	520	93
57	CeCoAl ₃	CeAl ₄ , CeAl ₂	CoAl	-	-	770	75
58	CeAl ₂	CeAl ₂	CeAl, Ce ₃ Al ₂	-	-	680	77
59	CuAl ₂	CuAl ₂	CuAl, Cu ₄ Al ₃	-	-	720	75
60	FeAl ₂	FeAl ₃	FeAl	-	-	780	72
61	TiAl ₃	TiAl ₃	TiAl	Al(5)	-	750	78
62	MnAl ₃	MnAl ₄	MnAl	-	-	700	74
63	LaAl ₂	LaAl	La ₃ Al ₂	-	-	620	83
64	FeAl	FeAl	Fe ₃ Al	Al(4)	-	830	84
65	CuAl	CuAl	Cu ₄ Al ₃	Al(3)	-	650	81

Table III

i	b	c	d	e	f	g	h
比較例	活物質組成	A相	B相	C相	その他の相	初回放電容量 (mAh/g)	容量維持率 (%)
1	Sn	-	-	Sn(100)	-	620	12
2	Al	-	-	Al(100)	-	730	5
3	Cu ₆ Sn ₅	Cu ₆ Sn ₅	-	-	-	550	34
4	FeAl	FeAl	-	-	-	600	29
5	Mg ₂ Ge/Mg	Mg ₂ Ge	-	-	Mg	530	22
6	Mg ₂ Sn/Mg	Mg ₂ Sn	-	-	Mg	490	33
7	Mg ₂ Sn/Sn	Mg ₂ Sn	-	Sn(30)	-	650	20

Table IV

The composition of each of the active materials that are used for phase A and phase B are described in the second column of Sato' Tables 1-3, where the composition of material elements are listed. (Sato, ¶ [0039]). In light of the following is a translation from Japanese to English of paragraph [0039] of Sato, it is clear that the elements in the second column of Sato's Tables 1-3 are not referring to crystal structures made of these elements:

"[Example] Next, the present invention will be described more concretely based on examples, however, this invention is not limited to these examples.

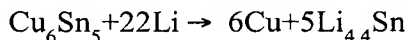
<<Examples 1-65>> Each active material, which has a composition (composition of material elements) shown in Tables 1-3 and includes A phase, B phase, another phase consisting of only elements selected from group (m²) (This phase is denoted as C phase in Tables 1-3. In the column of the C phase, numerals in parentheses represent weight % of C phase in each active material. The same is true for Table 4.), and other phases (In Tables 1-3, the indication "-" in the column of Other Phases is not the one for representing that other phases do not exist. The same holds true for Table 4.), was prepared according to the following procedure. A simple substance of each of the material elements was mixed at a given rate in massive form, in the form of plates or of particles, and casted in an arc melting furnace. The obtained cast was, under an argon atmosphere, converted to the form of spherical particles using a gas atomizing method. At this time, an injection nozzle was 1mmφ in diameter and an injection pressure was 100kgf/cm². The obtained particles were shifted with a 45 micron mesh to obtain active material particles 28μm in average diameter."

For instance, the active material of Sato's example 12 in Table I, which has a material elements composition with elements Fe, Mn, Sn₂, this active material includes five varieties of crystalline phases of FeSn₂, MnSn₂, FeSn, Mn₂Sn and Fe. That is, the active materials

described in Sato each have a plurality of crystal structures represented by A phase, B phase, C phase, and another phases (represented in column f of Sato's Tables 1-4). Therefore, and as further described in Sato's paragraphs [0009]-[0019], [0027]-[0036], and in his Tables 1-3 where material compositions are listed for the phases, each of the above-mentioned phases belongs to a *binary alloy system* or a *single-phase structure* such as Fe phase. Sato mentions in his paragraph [0009] that Ce can be an element of the composition, but fails to describe anything related to a CeNiSi₂ type crystal structure of a ternary alloy system.

Therefore, the active materials of Sato do not anticipate the features of Applicants' Claim 1 directed to a negative electrode including an alloy having a CeNiSi₂ type crystal structure of Applicants' Claim 1.

Moreover, Sato describes in his paragraph [0021] that "it is considered that this is because the difference between the expansive stress occurring when A phase absorbs lithium and that occurring when B phase absorbs lithium is small, and thus the expansive stress in the whole active material can uniformly be relieved." In other words, Sato teaches that both A phase and the B phase is made of active material *that absorbs lithium*. In addition, because the A phase and the B phase have a crystal structure of binary alloy system described in paragraphs [0009]-[0019], [0027]-[0036], and Tables 1-3 of Sato, when lithium is absorbed, a lithium alloy phase is generated. For example, with respect to A phase consisting of Cu₆Sn₅ described in paragraph [0027] of Sato, it is known that a charging reaction occurs, which will be a lithium absorbing reaction, as exemplified by the following reaction formula:



(See also Sato, Table 1, example 22, phase A.) As is clear from the above reaction formula that a lithium alloy phase such as Li_{4.4}Sn is newly generated, and lithium is *not* inserted inside A phase. As explained in Applicants' specification at pp. 52-53, it is well-known that

the generation of a lithium alloy LiSn in a charge-discharge stage brings about a substantial change in the volume of an alloy active material. Accordingly, the fine pulverization of the active material can cause a deterioration of the charge-discharge cycle. (See specification, from p. 52, l. 26 to p. 53, l. 4).

In contrast, as explained above, in the case where a lithium ion is inserted between crystalline layers in a charging stage, *no alloying reaction with lithium will occur*, and the inserted lithium ion is discharged from between the crystalline layers in a discharge stage. Therefore, in the charge-discharge stage, lithium ion can be inserted or discharged in or from between the crystalline layers without causing an alloying reaction with lithium to occur (See specification, p. 38, l. 22 to p. 39, l. 9). As a fact, Applicants' Figure 1 shows that after the charging and discharging a battery, a diffraction peak from the X-ray that is derived from the presence of the Li-Sn alloy was not observed. (See Fig. 10, specification, p. 60, l. 17 to p. 61, l. 13.)

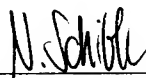
Accordingly, Sato fails to teach explicitly and inherently all the features of Applicants' Claim 1 related to the negative electrode including an alloy of a ternary alloy system having a crystal structure of CeNiSi₂ type. Therefore, Applicants respectfully traverse the rejection under 35 U.S.C. §§ 102(b) and 103(a) based on Sato.

Consequently, in view of the present amendment, no further issues are believed to be outstanding in the present application, and the present application is believed to be in condition for formal Allowance. A Notice of Allowance for Claims 1-3 and 7-11 is earnestly solicited.

Should the Examiner deem that any further action is necessary to place this application in even better form for allowance, the Examiner is encouraged to contact Applicants' undersigned representative at the below listed telephone number.

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